Citation:

Fisher JO, Mitchell DC, Smiciklas-Wright H, Mannino ML, Birch LL. Meeting calcium recommendations during middle childhood reflects mother-daughter beverage choices and predicts bone mineral status. *Am J Clin Nutr*. 2004 Apr;79(4):698-706.
PubMed ID: 15051617

Study Design:

Cohort study (longitudinal, prospective)

Class:

B - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

Evaluate calcium intake across middle childhood as a function of mother-daughter beverage choices and as a predictor of bone mineral status.

Inclusion Criteria:

- Girls from 5 counties in Central Pennsylvania with a mean age of 5.4±04 years and their parents.
- Girls living with both biological parents, absence of severe food allergies or chronic medical problems that would affect food intake, and the absence of dietary restrictions involving animal products.
- Overweight = BMI greater than the 95th percentile.

Exclusion Criteria:

None stated

Description of Study Protocol:

Recruitment

Girls and parents enrolled in a health and development study of young girls who were recruited through flyers, newspaper advertisements, and mailings within a 5-county radius.

Design

Anthropometric data from girls were taken. Three 24-hour dietary recalls and a milk serving practices survey were administered to mothers at daughter's ages 5, 7, and 9 years.

Statistical Analysis

- analysis of variance (age-related trends in girls' calcium and beverage intakes)
- analysis of variance and covariance (differences in mother-daughter beverage intake patterns

between girls who met the adequate intake for calcium and those who consumed less than the AI)
- multiple linear regression (relationship between calcium intake and BMD and BMC)
- logistic regression (evaluate predictors of girls' milk intakes)
- Spearman rank-order correlations (evaluate calcium tracking across time)

Data Collection Summary:

Timing of Measurements

Measured at baseline (5 years), 7 years, and 9 years of age.

Dependent Variables

Height, weight, bone mineral density (BMD) and bone mineral content (BMC).

Independent Variables

Mothers' and daughters' energy, calcium, milk, fruit juice, sweetened beverage, and non-energy-containing beverage intakes (all taken with three 24 hour recalls), and reports of milk serving practices and how frequently milk was made available to daughters at eating occasions.

Control Variables

Age, baseline intake of sweetened beverages at age 5, pubertal status

Description of Actual Data Sample:

Initial N: 197 five year old girls and their mothers

Attrition (final N): 182 mother/daughter pairs

Age: 5 years old at baseline

Ethnicity: White

SES: Approximately equal numbers of families reported income in three ranges: \$20000-\$35000, \$35000-\$50000, and >\$50000.

Anthropometrics: at baseline, 6.3% of girls were overweight

Location: Pennsylvania

Summary of Results:

Average total calcium intake at each age was calculated as the mean daily intake from all foods, beverages, and calcium-containing supplements. The girls' calcium intakes were categorized as either meeting or falling below recommendations across the 5-y period. Specifically, the girls' calcium intakes at each age were expressed as a percentage of the recommended adequate intake for that particular age.

42% (n=78) girls were categorized as meeting the adequate intake (AI) from ages 5 to 9 years, with a mean calcium consumption of 124±2% of the AI. Of the 59% of girls (n=114) who consumed less than the AI from ages 5 to 9 years, the mean calcium intake was 78±2% of the AI.

Calcium intake increase by about 10% from ages 5 to 9 years ($p<0.001$) with mean intakes of 852±25, 876±22, and 930±23 mg at ages 5, 7, and 9 years, respectively. 55% of 5 year olds and 57% of 7 year olds met the 800-mg/day recommendations. In contrast, 10% of the total sample consumed the recommended 1300 mg/d at age 9 years. The girls who met the AI at age 5 were 4.8 times (95% CI: 1.3, 17.0; $p<0.05$) as likely to meet the AI for calcium at age 9 as those who consumed less than the AI at age 5. The effect of calcium intake classification (meeting or consuming less than the AI) on girls' calcium intakes did not vary significantly by age ($p=0.06$). When the calcium intake at age 5 y was controlled for, the girls who met the AI showed a 277-mg/d increase from ages 5 to 9 y, whereas consuming less than the AI showed a 67-mg/d decrease ($p<0.0001$).

Girls who met the AI had higher mean energy intakes from age 5 to 9 than girls who did not meet the AI ($p<0.0001$); girls who met the AI were not heavier from age 5 to 9 than the girls who consumed less than the AI for calcium ($p=0.83$).

Mean calcium intake from ages 5 to 9 was positively related to bone mineral density at age 9 after control for stage of pubertal development at age 9 and was weakly related to bone mineral content after control for pubertal development and height at age 9.

Girls who met the AI consumed daily almost twice the amount of milk as did girls who consumed less than the AI (407 compared with 215 g/d; $p<0.0001$). Milk intakes did not vary significantly with age ($p=0.42$). Juice intake decreased by 26% ($p<0.001$) while sweetened beverage intake increased by 21% ($p<0.0001$). Non-energy-containing beverages showed an age related increase of >200% ($p<0.0001$) but was low in absolute amounts relative to intakes of milk and sweetened beverages. A main effect of calcium intake classification on beverage intakes from 5 to 9 years was observed for milk ($p<0.0001$) and sweetened beverages ($p<0.01$) but not for juice ($p=0.70$) or non-energy-containing beverages ($p=0.96$). Girls who met the AI consumed daily almost twice the amount of milk as did girls who consumed less than the AI (407 compared with 215 g/d; $p<0.0001$). Girls who met the AI for calcium consumed 18% fewer sweetened beverages from ages 5 to 9 years ($p<0.01$) than did girls who consumed less than the AI for calcium.

Milk constituted close to 50% of all beverages consumed (excluding water) by the girls who met the AI, which represented 11% of their total daily energy intake. Sweetened beverages represented close to 50% of all beverages consumed by the girls who failed to meet the AI, which represented 9% of their total daily energy intake.

When baseline milk intake at age 5 years was controlled for, greater decreases in milk intake from ages 5 to 9 years were associated with a greater mean sweetened beverage intake but were not associated with increases in sweetened beverage intake from ages 5 to 9 years.

Intakes of milk and sweetened beverages were positively associated with their mothers' intake of those beverages. Similarly, girls who met the AI for calcium had mothers who drank more ($p<0.05$) milk. Girls who met the AI for calcium were also served milk more frequently at meals and snacks than were girls who consumed less than the AI (3.7±0.1 compared with 3.2±0.1, $p<0.0001$, n=181).

Both sweetened beverage intake and juice consumption were not analyzed in terms of a possible association with overweight.

Author Conclusion:

Girls' calcium intakes from ages 5 to 9 years reflected the relative proportions of milk and sweetened beverages in their diets. The girls who met calcium recommendations were served milk more frequently than were the girls who failed to meet calcium recommendations and had mothers who drank more milk than did the mothers of girls who did not meet calcium recommendations. Milk availability to the daughters at meals and snacks appeared to explain the mother-daughter similarities in milk intake. Calcium intake from age 5 to 9 years predicted bone mineral status at age 9 years, which is evidence that maternal influences on daughters' beverage choices are relevant to the girls' bone health.

Reviewer Comments:

Strengths:

- *Prospective design.*
- *Generalizable to white female population who are at risk for developing osteoporosis in adulthood on the basis of ethnicity and sex.*
- *Mean milk intake in the sample was similar to that reported for 6 to 11 year old female participants of the Continuing Survey of Food Intakes by Individuals 1994-1996.*

Limitations:

- *Influence of season on dietary intake.*
- *Not generalizable to other races, gender, and subjects who are lactose intolerant.*

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions

1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	N/A
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	N/A

Validity Questions

1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes

	1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
	1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**		Yes
	2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
	2.2.	Were criteria applied equally to all study groups?	Yes
	2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
	2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	**Were study groups comparable?**		Yes
	3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	N/A
	3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	Yes
	3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	Yes
	3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	Yes
	3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A
	3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**		Yes
	4.1.	Were follow-up methods described and the same for all groups?	Yes
	4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
	4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
	4.4.	Were reasons for withdrawals similar across groups?	Yes

	4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**		???
	5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
	5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	???
	5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	???
	5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
	5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**		Yes
	6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
	6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	N/A
	6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
	6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes
	6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
	6.6.	Were extra or unplanned treatments described?	N/A
	6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	N/A
	6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**		Yes
	7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
	7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
	7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
	7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes

	7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
	7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
	7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**		Yes
	8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
	8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
	8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
	8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
	8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
	8.6.	Was clinical significance as well as statistical significance reported?	Yes
	8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**		Yes
	9.1.	Is there a discussion of findings?	Yes
	9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**		Yes
	10.1.	Were sources of funding and investigators' affiliations described?	Yes
	10.2.	Was the study free from apparent conflict of interest?	Yes